Name Date

HANDS-ON LAB

Test Stresses

Stress is a force applied on an object. In geology, there are different types of stresses that can act on rock layers. Compression is stress that squeezes rocks together. Tension is stress that pulls rocks apart. Shear is stress caused by forces that act parallel to each other, but in opposite directions. These stresses can often occur deep within Earth and in association with tectonic plate boundaries. Strain is the type or amount of distortion of the rock caused by stress. Other solid materials also experience strain when stress is applied. If the amount of stress that a material experiences is enough to exceed its strength, the material will bend or even break. Some materials that bend may return to their original shape when the stress is reduced or removed. This is called elastic deformation. Plastic deformation occurs when a material's shape is permanently changed.

Scientists and engineers use stress and strain measurements to choose the right material for a specific job. Think about a diving board. The material used for the board must bend when the diver presses down on the board, but it cannot break. It must rebound after the deformation to launch the diver upwards. Engineers compare the stress and strain measurements for different materials to choose a safe material for diving-board construction.

MATERIALS

- safety goggles, nonlatex apron, vinyl gloves
- air-dry clay, in squares
- modeling clay, in squares
- rulers (2)
- soft foam, such as used to cushion fragile items, in squares
- stiff foam, such as used to hold stems in floral arrangements, in squares
- wood block slightly larger than squares to be tested

In this lab, you will test two or more materials to determine how they respond to compressional stress, tensional stress, and shear stress. You will relate the characteristics of each material to how it responds to different types of stress.

RESEARCH QUESTION What characteristics affect how a material responds to different types of stress?

MAKE A CLAIM

Examine the different types of foam and clay provided. How do you think the materials will respond to each stress type? Which material will change the most when stress is applied? Will the change be permanent or temporary?

SAFETY INFORMATION

- Wear safety goggles, a nonlatex apron, and vinyl gloves during the setup, hands-on, and takedown segments of the activity.
- Remember to wet clay and clay dust before cleaning up to prevent exposure to potential silica dust.
- Wash your hands with soap and water immediately after completing this activity.

PLAN THE INVESTIGATION

Decide what materials you will test in the investigation. You will need to choose at least two materials and obtain three samples of each one. Each sample should have the same dimensions. You will also need to plan how you will apply compression, tension, and shear stress in a safe way to the materials. As you test each sample, you will need to quantify how much stress you are placing on the substance. You can compare the force you apply to the force needed to complete everyday tasks. For example, your scale could list values from 0–5, with 0 indicating no force and 1 indicating a small amount of force, enough to slide a pencil across the table. In this scale, a force given a 3 would indicate a medium amount of force, enough to slide a large textbook across a table, while a 5 might indicate a large amount of force, enough to move a table across the floor. It may be necessary to test each sample several times using varying amounts of stress. What force scale will you use? Describe it below.

Write a brief investigation plan in your Evidence Notebook. Have your teacher approve your plan before you carry out the investigation.

CARRY OUT THE INVESTIGATION

Label the materials you will test using letters (A, B, C…) and the samples of each material using numbers (1, 2, 3…).

1. Apply a force to place Sample 1 of Substance A under compression. Record how the material responds, as well as your estimate of the force applied.
2. Apply a force to place Sample 2 of Substance A under tension. Record how the material responds, as well as your estimate of the force applied.
3. Apply a force to cause a shear stress in Sample 3 of Substance A. Record how the material responds, as well as your estimate of the force applied.
4. Repeat Steps 1 to 3 for each substance you are testing. It also may be necessary to test each sample several times using varying amounts of stress.

COLLECT DATA

Use the table below to record the details of each test. You may need to use additional paper to create your own table, if necessary.

Sample	Type of Stress (compression, tension, shear)	Amount of Stress/Results

ANALYZE

1. Draw and label diagrams of how you applied three types of stress to the samples. Use arrows to show the directions of the forces involved in each situation.

2. Compare the materials you tested. What are the properties of each material?

3. **Patterns** Compare your results with other lab teams. What patterns do you observe in how the materials responded to each type of stress?

CONSTRUCT AN EXPLANATION

1. Explain how the properties of each substance determine how they respond to the different stresses.

2. When would it be useful to understand how materials respond to different stress types? Provide a real-world example of an object being subjected to type of stress.

DRAW CONCLUSIONS

Write a conclusion that addresses each of the points below.

Claim How do the properties of a material affect how it responds to different types of stress? Are the changes caused by the stresses permanent or temporary?

Evidence Use evidence from your experiment to support your claim.

Reasoning Explain how the evidence you gave supports your claim. Describe in detail the connections between the evidence you cited and the argument you are making.

EXTEND

1. In nature, stresses on rock do not always happen independently of each other. How do you think your substances will react to a combination of stresses?

2. If unused or un-deformed samples are available, apply two or all three types of stress to the sample at the same time. What happens?